Embracing ambiguity in management control and decision-making processes

Embracing ambiguity in management controls and decision-making processes: On how to design data visualizations to prompt wise judgement

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Abstract

Making decisions when managing organizations always involves the constant management of ambiguity and a great deal of complexity due to uncertainties and the intrinsic political nature of every decision-making processes. This paper argues that in order for management accounting to deal effectively with this ambiguity and uncertainty, both must be embraced, not suppressed, by the design of data visualizations produced by management controls as aids to the decision-making processes. Drawing on studies in rhetoric, alongside others on the rhetorical and communicative power of images and visualizations, this paper identifies a series of principles that can contribute to the development of a visual rhetorical framework to inform the design of data visualization (e.g. dashboards, business reports). The need to conceive of data visualisations beyond their representational function, and the principles that are identified, are then illustrated through the visual rhetorical analysis of a complex dashboard utilised in the programme management of the construction of a large airport terminal. The paper ends with an outline of a research agenda for the future design of data visualization in accounting, and beyond.

Key words: Business knowledge, Data visualizations; Rhetoric; Risk; Ambiguity; Uncertainty; Unknown-Unknowns, Wisdom, Major Programme Management.

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Writers and men of the cloth are the same in that way.
They can't afford to solve the mystery, because the next day they'd become irrelevant
(Judy Law in *The Young Pope*, by Paolo Sorrentino, 2016).

Introduction

In a world characterized by an increasing degree of uncertainty and ambiguity, the words used by James G. March to describe decision-making processes are as relevant now as ever before:

> "Many things happening at once. Technologies are poorly understood; alliances, preferences, and perceptions are changing; problems, solutions, opportunities, ideas, people, and outcomes are mixed together in ways that make their interpretation uncertain and their connections unclear […]; solutions seem to have only modest connection to problems; policies are not implemented; decision makers seem to wander in and out of decision arenas" (March, 2008, p. 36).

What James G. March described in this statement is the norm, not the exception, when observing how decisions are made in daily organizational lives.

Accounting and controls have often been seen as a response to this ambiguity. The supposedly accurate information that accounting provides is crucial in Chandler's history of the emergence of modern corporations (Chandler, 1977; Chandler and Daems, 1979), where accounting calculations play a key, albeit technical and seemingly neutral, role in orienting managers' 'visible hands' by providing them with information to make decisions on the efficient allocation of economic resources and effective coordination of organizational units. Some of the more sociologically inclined research on accounting and controls (see Chapman, Cooper and Miller, 2009 for a review) has placed similar importance on the relationship between accounting knowledge and decision-making. However, for this research stream, in communicating reality, accounting constructs reality (Hines, 1988). With their rhetorical power of persuasion, accounting and controls bring an aura of rationality to decisions (Carruthers and Espeland, 1991), especially when the relationship between knowledge and action is uncertain and ambiguous (Quattrone and Hopper, 2001). They are therefore more likely to appear as key organizational features when organizational actors face situations of uncertainty and opacity, thus becoming a cognitive tool to "count, not the visible, but the invisible" (Meyer, 1986, p. 351). Viewed as such, when both the objectives of the decision and its consequences are uncertain and ambiguous, accounting is a "rationalization machine" (Burchell et al., 1980) that operates to legitimise decisions or rationalise them 'ex post'. This is the realm of 'unknown-unknowns', to which March's opening quote of this paper alludes.

As Carruthers (1995) noted, expert accountants are aware of accounting's ambiguity as much as accounting scholars are aware that accounting representations are written (or virtual) inscriptions (Robson 1992; Preston, Cooper and Coombs, 1992; Chua, 1995; Dambrin and Robson, 2011; Qu and Cooper, 2011) that can only partially represent

organizational worlds. Such representations are therefore inherently incomplete knowledge systems (Quattrone and Hopper, 2005; Jørgensen and Messner, 2010; Dambrin and Robson, 2011; Wouters and Wilderom, 2008) that cannot fully inform rational decision-making, while being fundamental to prompting a desire for such a rational approach to knowledge and beliefs (Knorr Cetina, 2001). This attention to accounting and controls 'signs' and the effects that they generate on organizational action and decisions (Busco and Quattrone, 2015; Lipe and Salterio, 2000; Qu and Cooper, 2011; Wouters and Wilderom, 2008) has generated a growing attention to the materiality of these signs. In this sense, a number of studies have investigated signs as material platforms (be these screens or pieces of paper) through which, and in which, accounting and control data are visualised. From the layout of old accounting (text-)books and how they engage accounting users (Quattrone, 2009), to the role that figures, colours and other visuals play when communicating financial reports (Davison, 2015), via the effects that the presentation of accounting information has on decision-making (Cardinaels, 2008; Cardinaels and Van Veen-Dirks, 2010), we have witnessed a visual turn in accounting, control and organizational studies (Jack, Davison, and Craig, 2013).

This paper is inserted into this stream of works. By drawing on historical studies in rhetoric (Bolzoni, 1995; Carruthers, 1998; 2013; 2015) and combining them with studies on images and visualizations (Kress and van Leeuwen, 1996/2006; Stafford, 2007) and their rhetorical power (Kostelnick and Hassett, 2003; Kostelnick, 2004), this paper aims to construct a framework to inform the design of management control visualizations (e.g. dashboards, business reports) in a way that makes them suitable to deal with uncertainty and ambiguity in decision-making processes. The paper argues that as much as "words have a history" (Long, 2001), visual images and forms have a history too (e.g. Kostelnick and Hassett, 2003, pp. 50ff), although this tends to be forgotten and visual images acquire new functions under new conventions. Learning from such a history, and understanding the rationales and rhetorical principles which underpinned these images' design, can help to shed new light on the contemporary use and utility of management control visualizations.

The paper also aims to make clear that management control visualizations have further, and possibly more important, roles than the representation of organizational processes and performances. If it is true, even in the more professionally-oriented literature, that every "chart is a manipulation" (Berinato, 2016, p. 151), it is even truer that, when one deals with 'unknown unknowns' (which are, by definition, unrepresentable), management control visualizations cannot be seen and used as if they are truthful representational devices.

If there is one thing that the accounting community of scholars and practitioners has learnt in recent years (at least from Hines, 1988), it is that such images cannot convey 'truths', although it is equally true that such a truth cannot be stretched too far. Management control visualizations are therefore viewed in this paper and, I suggest, must be utilised in practice, as tools to question and envision what such representations cannot represent (Busco and Quattrone, in press).

Beyond a modern dream for accurate representations of objective data, and without the presumption of proposing a framework which will works in any given situation, this paper is therefore a step towards the construction of a "language of images" (Mitchell, 1980) in management control and in business more generally.

In order to illustrate this point and to give empirical content to the data visual design framework proposed, I will apply some of these principles to the analysis of a dashboard utilised in managing the construction of the satellite B of Terminal 2 at London Heathrow airport. The paper will conclude with an outline of a research agenda on the language of business visualizations, in order to better understand how to study and design them in a fashion that escapes positivism, while still playing a positive role in managing organizations of all kinds.

The visual turn in accounting studies: from a rhetoric of persuasion to a rhetoric of invention

It is not the aim of this section to provide a full literature review of the works on visualization in accounting and in organizational studies (for this purpose, see, for instance, Davison, 2015; Meyer et al., 2013). The aim is, instead, to show a shift in the way the literature is conceiving of the role of images and visualization in accounting and beyond.

The publications of works on the role of visualizations in business has recently mushroomed, with special issues of accounting journals (e.g. Hopwood, 1996; Davison and Warren, 2009), edited collections (e.g. Jack et al., 2013; Davison, 2015; Puyou et al., 2012) and comprehensive literature reviews (Beattie and Jones, 1992) devoted to the role that accounting visualizations play in business communication. The literature has shown how this role is particularly important when the contours of the business message are not well defined and ambiguous, as is the case, for instance, in intellectual capital (Davison, 2014; Mouritsen, 2003) and in corporate and social responsibility reports (Déjean, Gond and Leca, 2004).

In accounting, the study of the rhetorical power of double entry as a persuasive tool to engage various audiences has been explored by investigating both the images and the visualizations that populate accounting texts and manuals (e.g. Aho, 1985; 2005; Thompson, 1991), and those that surround accounting reports (e.g. Davison, 2008). The study of the "visual forms related to accounting" (Davison, 2015, p. 123, Table 1) ranges from photographs to cartoons, and in business communication more generally, it has also begun to involve videos, websites and social networks (Barros, 2014). These studies span history too, with some works looking at the evolution of accounting as a rhetorical practice (see the seminal pieces of Aho, 1985; 2005; Carruthers and Espeland, 1991; Thomson, 1991) and others concentrating on more contemporary settings concerning various forms of reporting (see, for instance, Davison's various works, including, 2008; 2014).

In general, as noted by Justesen and Mouritsen, a common theme "running through most discussions on the visual in annual reports is the attempt by the firm to convince an audience about the firm's capabilities and futures" (2009, p. 973) via strategies of impression management (e.g. Neu, Warsame, Pedwell, 1998) to ensure congruence and consonance with external expectations.

I have noted elsewhere (Quattrone, 2009; 2015a) that the link between rhetoric and accounting is not casual, and that the fact that the etymology of the word 'inventory' directs us to *inventio* (the first canon of rhetoric, Rossi, 2000) is to be intended as much more than a simple coincidence. Beyond the important persuasive role of accounting (Aho, 1985; Thompson, 1991; Carruthers and Espeland, 1991), there is a more profound and historical link between the revival of rhetorical studies in the late Middle Ages and Early Modern times, and the concurrent development of double-entry bookkeeping and the related formalization of the accounting craft in a growing number of accounting manuals.

Investigating these links and etymologies through a lexical strategy which links the text to its context ('context' indeed comes from Latin *com*, *cum*, 'with' 'together' and *textere*, Hoad, 1996) has helped us to appreciate the nature of both rhetoric and accounting as practices of knowledge invention and composition, rather than simply of persuasion. This has proved useful in understanding the contemporary power of accounting numbers to engage users (Quattrone, 2009) and help them to develop unfolding notions of rationalities (Quattrone, 2015a). It has also shed light on how certain management control figures operate today (see Busco and Quattrone, 2015, on the Balance Scorecard as a rhetorical wheel). This is why, in some of my works, my interest has shifted from the visualizations that appear in

manuals and reports, to seeing accounting numbers as figures themselves (e.g. Quattrone, 2009; Puyou and Quattrone, 2014). This shift has allowed me to conceive of accounting practices as forms of spatial thinking, problem-solving and decision-making, in line with some developments that view business practices as boundary (Star and Griesemer, 1989) and epistemic objects (Knorr Cetina, 1997) that facilitate both collaboration across different communities of practices, and change management (e.g. engineering drawings, Bechky, 2003; business models, Doganova and Eyquem-Renault, 2009; power point, Kaplan, 2011; and indeed, accounting, Briers and Chua, 2001).

A similar strategy of analysis can therefore be utilised here to sketch a framework that could lead to the construction of a grammar of images (Kress and van Leeuwen, 1996/2006) in the context of management control visualizations in order for their design to be made consonant with the need to make decisions in ambiguous and uncertain situations.

What follows combines insights from the history of rhetoric (Barthes, 1970; Carruthers, 2013; 2015) with works on visual design (Kress and van Leeuwen, 1996/2006; Stafford, 2007) and visual rhetoric (Kostelnick and Hassett, 2003) in order to distil a series of design principles that can shape the form of management control visualizations.

Building a framework for data visualization design in management controls and decision-making processes: a visual understanding of rhetoric

> "Rhetoric, Aristotle tells us, has to do with "things about which we deliberate but for which we have no systematic rules". [In a nutshell], rhetoric concerns uncertainty." (Miller, 1990, p. 162).

In her comparison between different approaches to decision making, Miller (1990) notes how the problem of uncertainty has often been dealt with as a problem of "discrepancy between the information available and information needed", in other words, uncertainty has often been treated as "a problem of knowledge" (Miller, 1990, p. 175). This tendency is currently augmented by the availability of large data sets and digital technologies that make us live in a "screen society" (Knorr Cetina, 2003) that continuously instils in organizational actors a desire for more knowledge and perfect information, despite the evident impossibility of epistemic objects to deliver their promises. Given the intrinsic and unavoidable incompleteness of the inscriptions that they produce (Latour, 1991; Quattrone and Hopper,

2005; Jordan and Messner, 2012), visualizations have to be understood as more (and/or less!) than representations.

A rhetorical understanding of uncertainty (i.e. one that is based on pragmatic practices to orient action), rather than an epistemological one (i.e. based on the assumption that uncertainty is solved with more knowledge), would generate this possibility as it would lead us to different sources, ideas and practices of decision-making. As Miller notes (1990, p. 175ff), at least since Aristotle, uncertainty has concerned human actions and not just human knowledge. While a focus on knowledge would ideally end with a binary choice between 'right', on the one hand, and 'wrong', on the other, a focus on action instead implies taking account of ambiguities and potential conflicts amongst organizational actors (March, 2008). The need for deliberations, be these management decisions or political choices, emerges because problems have multiple, and often conflicting, solutions. The distinction between epistemic and rhetorical understanding of decision-making processes is thus an important one to make and draw upon, in order to rethink the role management data visualizations play in decision-making processes.

In a language familiar to accounting literature, when one faces non-programmable decisions (Simons, 1990), accounting cannot work as an "answer machine", where more accurate quantitative methods and numerical calculations provide objective data to take better (and possibly best) decisions (Burchell et al., 1980). As it happens, people simply have "different beliefs about the uncertain future" (Miller, 1990, p. 177). This is why accounting has historically (with differences in temporal eras and geographical and cultural spaces), often been viewed as a means of scrutiny, as a platform to mediate different interests and as a source of procedural rationalities, which 'force' self- and collective reflection (Quattrone, 2015a) and "guarantee criticism" (Miller, 1990).

In other words, human actions always entail unavoidable conflicts, ambiguities, and tensions originating in different attitudes, objectives and beliefs. We therefore need a framework that embraces these conflicts, ambiguities and tensions rather than trying to align them while, in fact, marginalising organizational actors and making them ready to react and disrupt organising processes at the first available opportunity. Ambiguity and uncertainty have to be embraced (Novotny, 2016, pp. 144ff) rather than expunged. A visual understanding of rhetoric helps to do just that.

A visual understanding of rhetoric

Nowadays, rhetoric is mainly associated with persuasion and, most of the time, in a pejorative sense. However this has not always been, and does not have to be, the case. In the Middle Ages and Early Modern period, for instance, rhetoric was a method to explore ideas at a time when logic and rhetoric were much closer than they are now (Carruthers, 2015). Today, rhetoric is still seen as an instrument of inquiry in academic disputes, and of deliberation in public and economic affairs (McCloskey, 1985; Simons, 1990; Nelson et al., 1987).

In order for rhetoric to pursue this exploration and inquiry, it makes use of various types of mental and material images (Bolzoni, 1995). These images range from wheels (as those currently used in figuring out and pursuing strategies through Balanced Scorecards, Busco and Quattrone, 2015), to grids and matrixes (like contemporary excel sheets and budgets, Busco and Quattrone, in press), and hierarchies and trees (like those normally associated with modern bureaucracies, Chandler, 1977). What follows explores the principle that rhetoric is an art of imagery composition devised to prompt a reflection on the unknown, be this related to the mystery of God (as, for instance, in spiritual exercises), or when managing complex situations, such as missions to unexplored territories (Quattrone, 2015a).

In search of wisdom: sacred oppositions, the value of variety, and the need for aesthetical harmony

A key image utilised in rhetoric to classify and invent knowledge is the tree (see Bolzoni, 1995), which is used in managerial hierarchies thanks to the translation of the *Parisienne* pedagogy in the administration of the US railways through the West Point connections (Hoskin and Macve, 1988). The association between hierarchies and bureaucracies is thus somewhat misleading, as the origin of this specific imagery is to be found in a different space and time that does not coincide with the 'managerial'. Hierarchies are, indeed, often seen as instruments of subordination (Levine, 2015) and lines of command, control and coordination (from Frederick Taylor onwards), which make orders flow from top to bottom. This managerial understanding of hierarchies is not surprising as all kinds of images, charts and graphs are highly conventional, with their design "socialized by discourse communities that construct, adapt, and refine conventional practices and that enculturate users into those practices" (Kostelnick, 2004, p. 225). We are so used to seeing these images,

that we "are unlikely to regard them *as conventions*" (Kostelnick and Hassett, 2003, p. 15). Our understanding of the graphical design of hierarchies is not an exception to these conventions. Debunking them requires some work.

This is why, in this and other works, I have often gone back to the history of accounting terms and visualizations. The search for etymologies of accounting terms and the construction of carefully crafted analogies between current data visualization designs and their precursors belongs to lexical strategies of inquiry (Carruthers, 1990; 1998; 2013), which seeks to explore how certain everyday practices have the form they do today: understanding the forgotten use of these contemporary visualizations and why they were designed can potentially reveal what affordances they have as forms that organise our thinking and acting (Levine, 2015; Pollock and D'Adderio, 2012). Understanding the power of images, their functioning, their grammar and even their syntax (that is, how they are linked together; think, for example, of the links between balance scorecards and strategy maps) requires this kind of analogical and etymological work.

Hierarchies (and rhetorical trees; Ong, 1961; 1982; Bolzoni, 1995), those to which management scholars are so familiar, are central figures for understanding how rhetoric works both as an instrument of knowledge classification and of knowledge invention, composition and inquiry (Carruthers, 1998). They historically mediated vertically between celestial and terrestrial matters (hence the sacred nature of hierarchy, from *hieros*, sacred, and *arche*, rule). Horizontally, they established a creative tension between two equidistant opposites, in a "sacred geometry" (Lowlor, 1982) that inspired a sense of proportion, a *ratio*, which would have then generated a kind of '*ratio*-nality' (Quattrone, 2015a). Occupying and seeking a middle ground and a middle measure was a synonym of wisdom (Weyl, 1952) and the idea of a balance between two opposing poles was meant to be key to the exercise of good judgement (Kaye, 2014). The graphical design of hierarchies, in recursive analytical divisions (see Figure 1, for a representation of the Jesuit Order which could potentially allow the recombination of various organizational units and the continuous ordering of the Society), created a series of spaces 'in between', which generated a locus of interrogation (a negative space, Agamben, 1998) and allowed a third party to mediate between opposites, guaranteeing the productive role of the tension generated by the opposition. For accountants, where balance and graphical symmetry have characterised the whole history of the craft (Thompson, 1991; Puyou and Quattrone, 2014), these are quite relevant notions, especially given that *ratio* in Latin, also means 'account' (Goody, 1996).

Figure 1. *The universal Chronoscope of the Society of Jesus* (Kircker, 1646)

Rhetoric has, therefore, a "taste for tensions" (Carruthers, 2013, p. 22). This technique of purposefully seeking dissonance (Stark, 2009) was otherwise known as *controversia*, i.e. a practice of constructing "pairs of terms compared and contrasted, brought into neighbourly conjunction" in order to foster speculation and the exercise of judgement (Carruthers, 2015, p. 13). In the late Middle Ages and Early Modern period these rhetorical techniques were used in religious practices to foster the exercise of judgement via meditation and reflection, for example, when monastic practices utilised tensions and *controversiae* to make sure that friars used the known almost as an excuse for speculating about what they could not know (i.e. the mystery of God, Ward, 2015).

This taste for oppositions is the first of a series of principles that rhetoric has devised to understand how to design visualizations that are aesthetically harmonious, and may eventually prove helpful when making decisions in ambiguous situations (see Figure 2, a).

This tension was also crucial to make sure that one could use the known to interrogate, and eventually comprehend, the unknown. As Mary Carruthers eloquently stated in reconstructing the craft of medieval thought:

> "If I am asked to think about something that does not actually exist [e.g. a possible future and uncertain event], I can readily do so. No one has ever really seen a

black swan (*cignus niger*). But one can picture the bird because one knows what a swan is and what black is, and so the thought-image is readily made." (Carruthers, 2013, p. 50)

What we see here is a skilful *inventory*, i.e. a catalogue of notions classified in abstract categories or physical spaces, e.g. *cignus*, *niger*, which generates an *invention*, i.e. new knowledge, by the means of recombination (the second canon of rhetoric, *ordinatio* and *dispositio*).[1] The larger and more diverse the inventory, the greater the possibility of recombining the elements of this inventory to generate new knowledge. In this way, black swans (Taleb, 2007) have always been in our imagination and memory so that, when we eventually find one on our trip to the Antipodes, we are ready to understand and embrace it: embracing unknown unknowns requires a huge variety in the blocks that constitute our knowledge in order to foster our ability to imagine what we do not know.

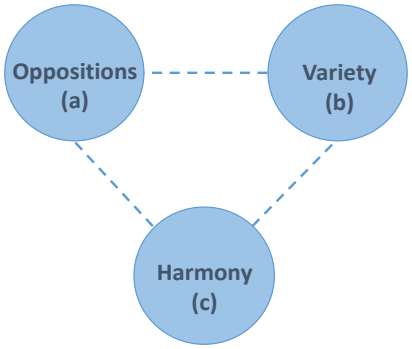

Figure 2. A triadic understanding of a rhetorical composition of imageries

This emphasis on symmetrical oppositions is thus augmented by the notion of *varietas*, i.e. variety, another feature that good rhetorical images should have (see Figure 2, b). *Varietas* in Latin "resists single definition. [It is] a word covering many degrees of experience along a continuum between opposites […]. The very imprecision of the measure is essential to its nature, for variety can never be one thing" (Carruthers, 2013, p. 136). Here we are back to the epistemic vs rhetorical understanding of uncertainty and ambiguity, where

[1] I have explored elsewhere, drawing on Carruthers (2015), how accounts (Quattrone, 2015a), excel sheets and matrixes (Busco and Quattrone, in press) operate a mechanism of compression (i.e. reducing complex phenomena to calculable signs) and augmentation (i.e. interrogating what cannot be represented in the sign and therefore in the calculable space). In analysing the dashboard of London Heathrow T2b, I will return to this mechanism to explore how it rhetorically works in visual terms.

the natural tensions that characterise political and organizational lives are reproduced in the system that aims to make sense of them.

Varietas lays the ground for the exploration of different *ducti*, i.e. patterns and paths (Carruthers, 2010), and thus requires the exercise of judgement when choosing the way to follow. It requires *arbtrium*, which will eventually lead to harmony. Variety is an essential feature of every rhetorical composition, from music (as in polyphony, where "the harmony is produced [by] a combination of disparate voices sounding together", Carruthers, 2013, p. 141) to visual representations which become "polyfocal" (Carruthers, 2013, pp. 151ff), i.e. they require the eye to continuously move across them, thanks to a high degree of difference in the technical composition of the image (e.g. different colour, sizes etc). Figure 3, for instance, works in a polyfocal way: given the different sizes of the painted characters and the background colour of the fresco, the eye moves from one point to another making counting the devils represented in the picture difficult, as the convention of the folkloristic tradition wants (Pitrè, 1871-1913/1981).

Figure 3. *I diavoli della Zisa*, Palermo, Castello alla Zisa
(Source: www.wikipedia.it, accessed on 06/01/2017)

Like Byzantine icons (Pentcheva, 2010, p. 2), which are performative not because they force the user to see the icon in a unique way, and thus convene a given message, but because they transform the spectator into a participant to the visual and sensual experience generated by the aesthetic of the icon, visualizations designed in a polyfocal manner call for the viewer to choose where to look first (Carruthers, 2013, p. 161): "Rather than transparence, here the sought-out aesthetic is that of layered opacity, of solid yet coruscating

covers" (Pentcheva, 2010, p. 148). The polyfocality of the *varietas* generates and draws upon ambiguity, which then becomes a key element to prompt judgement and wisdom: *varietas* becomes the space '*in between*' aesthetic and ethics, making them meet.

And yet, this epiphany of variety and difference does not have to be pushed beyond a certain limit. One would otherwise run into the unintended consequences of making the viewer/participant confused. As argued by Pollock and Williams (2017, p. 250), in relation to the famous Gartner's Magic Quadrant, this 2x2 matrix does not have to be representative of all firms operating in an industry in order to construct a market for their solutions: too many dots in the matrix would leave the viewer confused, offering her too many cues to follow. Similarly, in medieval rhetoric, for *varietas* to be generative and effective, *curiositas* was not to be fostered to the limit of becoming superfluous or confusing (Carruthers, 2013, p. 150). Understanding where to stand in the opposition between *varietas* and *curiositas* required skilful training and an acute sense of aesthetics: it required aesthetical harmony (Figure 2, c).

Operationalising wisdom: in-tensions, di-visions, in-difference

I have noted elsewhere how the composition of rhetorical images requires the visual to be conceived as a performable space (Busco and Quattrone, 2015) in which the participant is called on to perform an activity. Here I add that this action also implies the making of a choice, in terms of what path to follow, with the eyes moving along and across the visualization itself. Given the moral and pragmatic nature of rhetorical compositions, utilised in fields as disparate as meditation and accounting, their purpose was to foster action and choice. In other words, the rhetorical composition of the figure that the visualization affords always implies the choice of a path, a *ductus*. This choice requires an *intentio*, i.e. an intention, a purpose (from Latin, *intendere*, 'to turn one's attention', literally 'to stretch out'). But this intention does not have to be understood as a fixed purpose, an immanent teleological and functional objective, as most functionalist management practices do. It needs to be interpreted instead as a "movement" around the various paths that the visualization offers. In that sense, an *intentio* is always "*in*-tension" (the first design principle, as in Figure 4, a). As much as the modern accountant has to move across the different spaces represented by the accounts in a chart of accounts, the medieval viewer finds herself navigating the visualization as if she was entering a maze, which offers, through the convolutions of its

various paths, an opportunity of choice, and therefore an opportunity for reflection and the exercise of judgement.

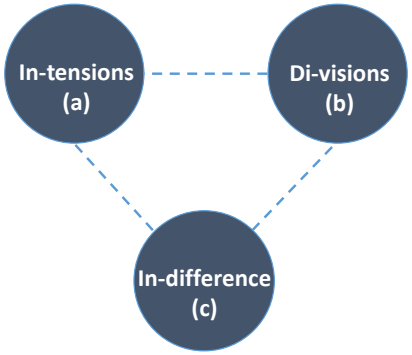

Figure 4. A triadic set of design principles for a rhetorical composition of imageries

This choice requires, though, a calculable ability that goes beyond numbers and extends to "manipulating letters, bits of text, and common places" and, not lastly, colours (Carruthers, 1998, p. 19). A calculative skill which is both highly spatial and highly visual, as the etymology of the word 'division' suggests (from Latin, *de*-, 'to be about' and *dis*, 'two' + *videor*, i.e. to see but also to imagine), the tension between two opposites (a spatial separation) allows seeing and imagining things better (the second design principle as in Figure 4, b).

But what makes these judgements and calculative abilities wise? The key is in the attitude towards these different choices, towards this epiphany of difference. In order to navigate this difference and embrace the ambiguity generated by the multiple paths and courses of action, one has to inhabit the middle ground of the *diversitas*, i.e. one has to be '*in*-different' to different choices (the third design principle as in Figure 4, c; see Quattrone, 2015a, in relation to rational vs reasonable choices). It is this indifference that makes rhetorical and logical oppositions productive, as it is standing in the middle of them, in an equidistant (*ratio*-nal) position between the two, that makes the viewer see but also generate unity out of difference, by keeping the opposites together (see Quattrone and Hopper, 2006 on IT systems as "heteromogeneous objects").

It is this complex balance between opposites, between *varietas* and *curiositas,* between the different views, conflicts and beliefs, that make calculations possible even when they concern what cannot actually be positively represented, and therefore needs to be imagined. It is the combination (and recombination) of 'di-visions', in-tensions' and 'in-

difference', supported by a proportioned variety, opposition and harmony, that in rhetoric informs a wise and aesthetically balanced composition of images and, for the aim of this paper, visualizations.

In summation, to see the unseeable, be this the black swan of modern theories of complexity or its analogous ancestor (the *cignus niger*), one requires 'imagin-ation', that is, the action of composing images of the unknown (either in the mind or on a piece of paper or a screen), not representations of it: *Videor* is "the verb of imagination and envisioning", not of mimesis (Carruthers, 2013, p. 40).

This shift, from a representation of 'passive' objects to a productive imagination operated by rhetoric, is made possible by what I call a visual rhetorical apparatus for Data Visual Design (see Figure 5), which I will utilise in the remainder of this paper to inform a visual analysis of the design of one of the dashboards used in the management of the construction programme of Terminal 2a at London Heathrow airport.

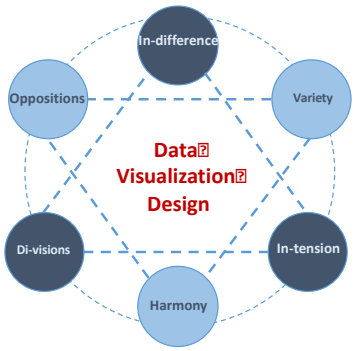

Figure 5. A visual rhetorical apparatus for Data Visual Design

It is this apparatus that lays the foundations for a visual based "rhetoric of inquiry" (Simons, 1990) that can then be utilised to design what Churchman defined as "inquiring systems" (1971). These systems, in the context of accounting, do not seek to provide users with answers but seek to elicit questions, scrutiny, judgements, and wise choices. Visualizations are therefore epistemic objects of experimental inquiry (Stafford, 2007, p. 6), which build upon their incompleteness and ambiguity. What I am proposing here, and have begun to outline elsewhere (Quattrone, 2015a, b, c; Busco and Quattrone, in press), is a Socratic approach to the design of accounting visualizations, where answer machines (Burchell et al., 1980) have to be supplanted by maieutic ones, where the term 'maieutic'

refers to the Socratic method of generating knowledge by asking questions (from the old Greek, *maieuticos*, 'midwifery').

Exemplifying data visualization design: insights from the analysis of a dashboard

This section does not presume to offer an empirical proof of the principles and practices that I have described in the previous section. Rather, it provides, as would be the case with the rhetorical structure of early modern 'how to do' books (Oldrini, 1997), an example of such principles and practices in order for the reader to appropriate them as they find suitable.

The dashboard reproduced in Figure 6 is from a much broader project on reporting and governance practices in major programme management. It refers to one of the various project controls used to keep track of the construction of London Heathrow Terminal 2a.

Figure 6: Visualising 'Di-visions', 'In-tensions', and 'In-difference'
(source: EC Harris/Arcadis company material, with adaptations)

As is often the case with images (Kress and van Leeuwen, 1996/2006, p. 79), one of the first things this visualization does is to produce relations, in this case among four distinct but related aspects of every individual programme or project: Schedule, Cost, Safety, and Risk. Everyone familiar with major programmes knows the adage 'Safety first!', which was

particularly relevant for this major programme given the excellent safety record that it enjoyed. Forms indeed prioritise and subordinate (Levine, 2015), and often produce a "covert taxonomy" (Kress and van Leeuwen, 1996/2006, p. 78), where certain features of the story are subordinate to others, although this subordination is not explicit. This visualization is instead built on a series of dichotomic oppositions (see Figure 2a) which are conceived as logically opposed and geometrically proportioned: it embeds oppositions that lead to a division of space based on logical tensions (see Figure 4a,b). This not only relates to the graphical design of the four areas and the space that they occupy on the dashboard; it also relates to the implied logical relations amongst these four aspects of the programme: one cannot increase the speed of delivery without incurring greater costs, nor can one reduce costs without risk of ruining the excellent safety record. In other words, this data visualization is a 'topology', where space and logic are intertwined, in this case in a "compositional symmetry" (*ibidem*, p. 89; Weyl, p. 1952) in order for them to generate effects on the viewer (Kress and van Leeuwen, 1996/2006, p. 99) through processes of non-verbal thinking (Ferguson, 1992).

This visualization then constitutes the space for this conflict to not only take place (Miller, 1990) but also to be purposefully orchestrated and mediated, in order to make these tensions potentially productive and creative (Lowy and Hood, 2004, pp. 10-11). It reproduces but also generates a series of tensions that work not only horizontally and vertically but also, as in polyfocal images, diagonally (Carruthers, 2013, p. 13).

This polyfocality is also expressed in other aspects of the visual design of this dashboard. Firstly, through the *varietas* of its composition (See Figure 2b), the viewer is presented with a plethora of now-familiar shapes and forms (pie and bar charts, histograms, arrows) and colours (white, green, black, red), which can be operationalised thanks to those visual conventions that characterise Western (and increasingly global) contemporary management practices, as well as those specific to this organization and programme. Secondly, through the dynamism and movement that it generates, the eye is "forced" to move up *and* down, back *and* forward, left *and* right as in a maze, in a searching process where programme managers do not exactly know what they are looking for until they have found it (Stark, 2009, p. 1).

These supposedly scientific and objective representations are much closer to a work of art than we can possibly imagine. Kress and van Leeuwen (1996/2006, pp. 85ff) elegantly teach us that images have "carriers" which denote the whole (the LHR T2a programme in our

case), and "attributes" which define the whole in terms of certain features and not others (e.g. schedule, cost, safety and risk) and, in our case, according to certain canons (e.g. quantitative vs qualitative information). In relation to Figure 7, for instance, they note how van Doesburgh's *Pure painting* is not too dissimilar from a map, as it tries to tell something about a reality, but does so partially and in very abstract terms, with "rectangles of different size and colour" which do not define the carrier or the attributes of the whole: The painting thus "leaves the viewer to do so" and "is open to many readings" (*ibidem*, p. 90) which are not imposed by a representational or perspectival gaze, but actively chosen by the viewer who operates within the frame that the painting offers.

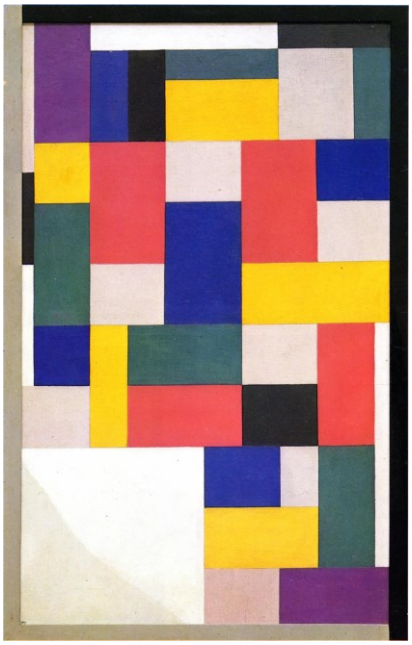

Figure 7. *Pure painting* (Theo van Doesburg, 1920)
(quoted in Kress and van Leeuwen, 1996/2006, p. 91)
(source: commons.wikimedia.com, accessed on 06/01/2017)

As Pentcheva notes in relation to Bizantine icons (2010), here as much as in the dashboard the viewer is not a spectator but a participant, an organizational actor who wanders around the visual space. These images are *imagines agentes*, i.e. acting images (Carruthers, 1998), because they "demand" (Kress and van Leeuwen, 1996/2006, drawing on Panovsky, 1953) the viewer to do something. This is the case, for example, for 'Uncle Sam' when he states "I want you" and calls for youths to go to war (Mitchell, 2005, see Figure 8).

Figure 8. Uncle Sam (J. M. Flagg, 1917)
(quoted in Mitchell, 2005) (source: www.wikipedia.com, accessed on 06/01/2017)

These visualizations and pictures also reveal a certain lack of complete information, in the case of LHR-T2b; of priorities, as is the case in *Pure painting*; and of ability to go to war, as in "Uncle Sam", who therefore has to rely on "you" to fight the war (Mitchell, 2005). They are not (and in most cases cannot) be exhaustive (i.e. they do not intentionally include all of the features of the carrier, Kress and van Leeuven, 1996/2006, p. 96).

This lack of 'exhaustivity', in the case of major programmes and more generally, becomes an ontological as well as epistemological issue. It concerns the very nature of the programme (which is difficult to define for all kinds of reasons ranging from the technical to the political), and not just the impossibility of representing it (on the ontological vs epistemological approaches to complexity and knowledge, see Law and Singleton, 2005).

The case of the HMS Queen Elizabeth aircraft carrier programme is a case in point. If we think of this artefact as a warship, we would considerably limit our ability to manage the programme, because it is so much more than that: it is a hotel, a nuclear power station, a small community of thousands of workers, a research and development department, a defence weapon and a political deterrent, for instance. Yet, this multiple ontology is also emergent and in a state of flux as this warship has the potential to become even more than this list implies. It has the tendency to become "other than itself" (Ricoeur, 1990; Latour, 1993), when, for instance, large programmes such as this are mobilised for purposes that were not imagined or defined at the inception of their long life. In order to manage them, it is

necessary and useful to define and think of them in negative terms: “This is not a warship!” is a much more useful statement to describe the artefact and manage its construction and delivery than its positive counterpart (see Figure 9).

HMS Queen Elizabeth aircraft carriers
‘This is not a warship!’

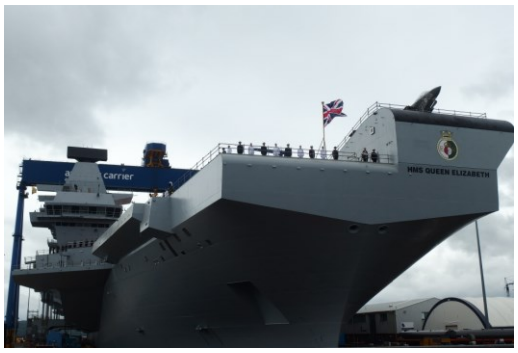

Figure 9. *This is not a warship!* (photo by Tony Graham, with permission from the author, and adaptations)

This is why financial reports about major programmes often include, and are closed with, an ‘allowance’ rather than a ‘result’: the allowance is a “matter of concern” which fosters political and technical debates (concerning the size of the allowance), creativity and invention (to address the concern effectively). A measured performance, instead, tends to be interpreted as a “matter of fact” and is more backward than forward looking (Latour, 2005; Mouritsen and Revellino, 2015).

Figure 10: In-different and un-decidable spaces (source: EC Harris/Arcadis, with adaptations)

Our dashboard also expresses a ‘lack’ in the sense of a central space of undecidability (see the central grey area of Figure 10), a space ‘in between’ the four tensions that cannot be aligned and that therefore forces a debate amongst the four managers accountable for schedule, cost, safety and risk, making them embracing the unavoidable ambiguity and uncertainties that characterise large projects. A debate should be orchestrated by the programme director, who ideally occupies this central space in a way that is theoretically ‘indifferent’, i.e. that cannot give institutional preference to any of the four aspects while making daily decisions on which of these aspects are to be pragmatically prioritised (see Figure 4c). Only this indifference can lead to harmony in the programme. As Mary Carruthers reminds us, a rhetorical space is always “social and political, requiring not just actual knowledge but wise judgements. [Rhetorically] derived truths are ‘opinions’ (*doxa*, *opiniones*) [which] are contingent upon circumstances and particular occasions” (Carruthers, 2013, p. 42). These judgements “need to be confidently made, so belief is not entirely a matter of logical demonstration […] but also requires ‘feeling confident’ in one’s particular decision” (*ibidem*). A confidence (*cum fides*) is always a matter of belief and credos, and is formed thanks to practical experience and careful theoretical training. It is this experience and training that allows programme managers to deal with the contingent situations that abound in major programmes, and keep them awake at night and alert during the day.

We are back to that imaginative, rather than mimetic, nature that a rhetorically informed understanding of visual design reveals. Figure 10 shows how the dashboard cannot fully represent the programme (as the whole in the middle of Escher's *Print Gallery,* to which I refer in Quattrone, 2000), but constitutes and offers us (or the programme manager) the "scaffolding that support[s] our thinking" (Stafford, 2007, p. 22). The structure of the dashboard does not speak so much about the inner structure of the programme, which is selectively described in terms of 'safety', cost', 'schedule' and 'risk', given the practical impossibility of giving a full account of the programme on an A4 page. Rather, it tells a lot about the inner mental structure of the "habit of the minds" (Kostelnick and Hassett, 2003, p. 23) of the programme managers who have designed it, and recursively use it. Such a habit is made of spatial thinking and visual conventions that constitute a "rich arsenal of analytical means" (Lefèvre et al., 2003, p. 84), and is a powerful tool of reflection and imagination, not just representation.

The dashboard is therefore in between the performative power of images (which try to constrain viewers) and the performance that allowed (which liberates and empowers them). It provides a narrative to the project, but also narratively constructs the identity of the managers involved in its design and use, in a triadic relationship between the dashboard (i.e. the aesthetic work), the programme manager (not only the designer of the dashboard but also the users who, thanks to their wandering around the complexity of the dashboard, make it work differently every time they use it), and the various and emerging stakeholders (be they firms in the supply chain, local authorities, team members, or political stakeholders) intertwined with the programme and who have to be enticed and managed as well as 'fought' when truth is stretched too far, or organizational politics become unmanageable. Such triadic relations (see Figure 11) co-define the contingent function of the dashboard itself, making the symbols it portrays (e.g. charts and arrows) work as "generative symbols" (Stafford, 2007, p. 16). The dashboard is not a simple representation, but an "echo object" (Stafford, 2007) that requires a community for it to work.

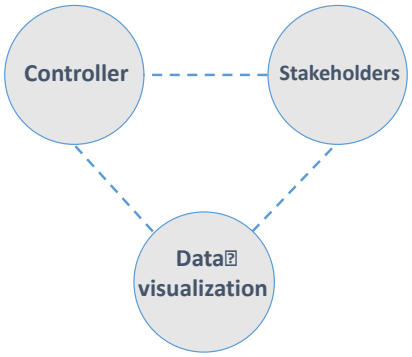

Figure 11. The triadic relation of data visualizations designs

This is also a dashboard where the relationship between the centre and the margin is constantly in a state of flux, as what is marginal one day can become central the next. As in Medieval manuscripts, on which the modern gaze had not yet acted as a subordination mechanism, rendering some aspect of an image more prominent and therefore more important than others, the page constituted an engagement space where margins (the decorations on the board of the page) and the centre (the body of the text) are in a constant state of relationship and flux (Camille, 1992).

The centre of the dashboard, though, is the space that a skilful programme director must inhabit in order to find harmony in the programme (see Figure 2c). Like in polyphony's *discordia concors*, numerical and proportional relationships "unlike sounds concord with each other", generating "the eternal harmony of life and of the conflicting elements of the whole world [which] is united as one with material things" (Carruthers, 2013, p. 160): a unity made of difference rather than homogeneity, a unity that embraces rather than suppresses: a form of communication becomes therefore a form of governance (Quattrone, 2015a, c).

What we see in this data visualization is a dual and synchronic process of compression, where the ambiguities and uncertainties of complex programmes are reduced to numbers and graphical signs, and of augmentation, where what is known, e.g. a measure, is used to interrogate what cannot be known (see Carruthers, 2015; Stafford, 2007). It is the same rhetorical process that allowed the geometrical construction of gothic cathedrals, where "complex sets of anticipated spaces, events, and circumstances […] were compared and assessed" in order to then be "*expanded* in the laying out of the edifice" (Murray, 2014, p. 200). This process resembles Latour's *circulating reference* (1991, p. 72) where every inscription reduces the complexity of the represented phenomenon to numbers, but also

amplifies the possibility of our understanding by producing standardised, uniformed and comparable figures. In our dashboard this happens too, but the augmentation does not end with standards that close the range of possibility but with images that open, and augment, our ability to deal with the unknown, thus making us not only want and desire for more of these representations (Knorr Cetina, 1997), but also hope and believe that these figures will eventually help us to deliver the programme. The dashboard of Figure 10 embeds all of these data visualization design principles in a way that makes it of a rare aesthetical beauty and effectiveness.

Towards an understanding of the language of business knowledge: a research agenda for data visualization design

> "We still do not know exactly what pictures are, what their relation to language is, how they operate on observers and on the world, how their history is to be understood, and what is to be done with or about them." (Mitchell, 1994, p. 13).

Mitchell's statement above is still very true today, in all of its facets. We are just at the beginning of a process of understanding how images (see Davison, 2014), business charts (e.g. Pollock and Williams, 2017) and accounting formats and graphs (e.g. Thompson, 1991) affect the way in which we conceive of organizations, markets, societies and relationships between various organizational actors and external stakeholders (Bell et al., 2013).

The statement is also true in relation to our lack of understanding of the genealogy of business visualizations. Drawing the contours of a research agenda for better understanding data visualization design cannot thus ignore the development of a historical analysis that draws together the various uses, translations and cultural influences through which these visualizations have historically developed. As beautifully shown by Paul Crosthwaite, Peter Knight and Nicky Marsh in their exhibition *Show me the money* (Crosthwaite et al., 2014), understanding the culture that surrounds and is constituted by visual and material artefacts requires attention to be paid to broader echo systems of cultural, business and economic knowledge and practices. In Mitchell's words, picture theories require "a critique of visual culture that is alert to the power of images for good and evil and that is capable of discriminating the variety and historical specificity of their users" (Mitchell, 1994, p. 3). The same applies to the study of data visualization design.

In an era fully dominated by images (increasingly produced, diffused and translated by new forms of digital communication), it is not paradoxical to call for a historical, and therefore intrinsically cross-disciplinary, understanding of those visualizations whose function and role we now take for granted. This is the case, for instance, with organizational charts and their hierarchical layout. Is there any scope for the design of images that either debunk this taken-for-granted and implicit subordination (Levine, 2015) or utilise more 'democratic' representations where proportionate tensions and relationships are fairly pictured, and therefore potentially generate different kinds of social interaction? In this paper and others (e.g. Busco and Quattrone, 2015), I have tried to show that this is possible. In trying to achieve this aim, the combination of history and cross-disciplinary work repays the enormous effort required (or at least it repaid my *curiositas*!).

Mitchell also noted that:

> "Images are certainly not powerless, but they may be a lot weaker than we think. […] That is why I shift the question from what pictures *do* to what pictures *want*, from power to desire" (Mitchell, 2005, p. 33; emphasis in original).

The analysis of the dashboard that I have performed in this paper to exemplify some principles and practices of data visualization design also shows how pictures are less (but also more!) powerful than we normally think. This is why I have refrained from venturing into the analysis of works that treat the visualization of data as a simple problem of communicating 'data' to a recipient audience, as for these works the meaning of 'data' is given and not also 'attributed', as an etymological analysis of the term would powerfully reveal (from Latin *datum*, i.e. with the meaning 'given', but also given by the observer who generates such *datum*). When studying the power and weaknesses of data visualizations, the questions we should therefore ask ourselves are: "what does this picture lack; what does it leave out? What is the area of erasure? Its blind spot?" (Mitchell, 2005, p. 49).

A second item on a research agenda for understanding data visualization design therefore has to start from this 'lack' that every representation entails, and not from its supposedly mimetic power that is its ability (or even a Popperian aspiration) to represent. Works on epistemic cultures (Knorr Cetina, 1999) have begun to explore how 'lack' generates greater desire for epistemic objects such as scientific representations. As with mirrors that prompt a desire for perfection, despite the fact that one never likes the reflected image, accounting reports have the same power. It is a rhetorical and reflexive power, as I

have signalled with reference to the metaphor of the mirror to describe the accounts in Early Modern accounting treatises (Quattrone, 2009). However, why we keep looking at ourselves in such a mirror despite the failure to reach perfection (or even improve) is still not understood. In this sense, accounting practices are closer to religion than to economics, as they instil hope in the user, the hope of finding a solution to a wicked problem, of making the 'right' decision, of making more money (see Quattrone, 2015a). Much more work is required to understand the composition of accounting numbers in reports as figures, that is as combination of numbers, texts and graphical layout. Kress and van Leeuwen (1996/2006), for instance, illustrate how the analytical composition of images contributes to the generation of such hope and stratification of desire. In advertising, they argue, important and evocative dreams are shown on the upper part of the image (think of a car travelling on an imaginative traffic less route on a beautiful landscape), while the technical specification and the closer-to-reality features are subordinated in the lower part of the advertisement. Data visualization designs are not dissimilar, although they may show reversed orders, especially in accounting where a plethora of divisions segment the space of the report (e.g. expenses vs. revenues, assets vs liabilities). In value added statements, for example, one may witness this inversion where the production of value (with its technical aspects of manufacturing, costs of goods, production factors) dominates the upper part above the line of 'Value Added', while the part below is all about dreaming for a better future, with a hopefully equal distribution of value amongst different kinds of stakeholders (see Quattrone et al., 2014). The dynamic between these divisions and the kinds of interactions, social contracts and promises they generate is something to which accounting scholars and practitioners have paid extraordinarily low attention. The study of what is otherwise known as the "semiotic of passions" (Greimas and Fountanille, 1993) seems therefore to me another interesting area worth developing (see for instance, Boedker and Chua, 2013).

This emphasis on passions, wants and desires, hope and beliefs, immediately prompts the need for a much broader understanding of the aesthetical experience that visualizations prompt. While we are now bound to the "tyranny of transparency" (with the 'eye' seen as the most powerful instrument of knowledge), we forget that knowledge and its aesthetical dimension (and therefore decision-making processes), are "bound to human sensation and that human knowledge is sense derived, the agents of which are all corporal" Carruthers, 2013, p. 8). Not by chance, more fully bodily experiences can lead to different strategies to

cope with uncertainty in trading due to new form of socio-material arrangements (Beunza and Stark, 2003).

The emphasis on the lack of representation power also calls for a new vocabulary that goes beyond representation, in both qualitative and quantitative approaches (cf. Tufte, 2007). As Barbara Stafford noted in relation to terms such as 'representation' and 'meaning', "what exactly do these terms mean? When refracted through the glass of neurosciences, humanists are troublingly reminded of how equivocal these concepts have become" (2007, p. 140), especially because of the emergence of new technologies that show the intrinsic nature of mental processes and how these shape viewing, thinking and feeling. However, this problem also affects the neurosciences themselves, for "when the same concepts are viewed from the perspective of the history of images, it is striking how the neurosciences are struggling to find 'neutral' that is, unproblematic, replacements for the venerable and nuanced humanistic vocabulary of 'representation', 'symbol', 'resemblance'" (*Ibidem*).

This is also true when trying to develop a new language and grammar of visual design, and is especially true when explaining visual interactions and procedures, rather than just forms and meanings. The polyfocal images (see Figures 4, 5) in this paper illustrate the need for a study of the procedural logic of visual interaction, not only among the various elements that they offer and the respective actors that are accountable for them, but also with broader audiences (see Figure 9). The four areas of the dashboard, for example, generate a continuous movement across it, and a series of shifting meanings that are generated by the social interaction between the four related programme managers, who also must interact with their team and manage a large and changing number of stakeholders. We are used to assessing the quality of a data visualization design on whether it 'represents' performance well, but we are quite distant from judging its quality in terms of how it makes people interact.

A last, but by no means least, important point for this research agenda concerns visual conventions (Kostelnick and Hasset, 2003), which naturally lead to training practices and content and the ability to critically interpret data visualizations and their wise design. In reflecting on how I have 'composed' this paper, I have adopted a highly interdisciplinary approach, but also faced quite substantial difficulties as I am not trained in visual methodologies, although I am a trained accountant. The question here is for accounting scholars who have to invest in regaining an understanding of 'numbers' as 'figures' (Pietra, 1586) - that is, as pictures - which accountants mobilise in spatial forms of thinking (as, for

instance, is the case when organising charts of accounts and carefully allocating accounts to physical and virtual economic spaces, such as cost and income centres). There is a need for accounting scholars and practitioners to become "visually fluent" (Kostelnick and Hassett, 2003, p. 24) when we speak and practise the graphical language of accounting. The issue also concerns accounting bodies and the content of their curricula. Particularly, when the accounting profession is called on to rethink the way it addresses issues of inequality and its response to the challenge of machine learning and block chain, what room does the accounting curriculum have for training new accountants as skilful data visual designers? In what ways can we teach a new generation of accountants not to exclusively prioritise shareholders' value (currently in the format of a conventional P&L, all geared towards profit to be distributed to shareholders), and to devise more sustainable forms of reporting and to contribute via new forms of calculations to new forms of societies?

Perhaps another journey into the past could provide insight into how to move forward. Not many know that in the early days of the British accounting profession, preliminary entrance exams to later qualify as a chartered accountant included subjects such as French, German, Greek, and Latin (Puyou and Quattrone, 2014). This very likely related to selection concerns and the need to legitimise new professional bodies with the admission of a selected elite. It also related, though, to the attention paid to assessing logical abilities and to selecting candidates with a broad and fully rounded education. This was a way to ensure that new accountants avoided being fooled by a disproportionate "trust in numbers" (Porter, 1996). I am not calling here for the reintroduction of Latin in the curriculum (I like etymologies disproportionally as you will have noted, but not to that point). But in order for a new accounting Renaissance to happen, a new form of humanist approach to judgement has to inform the way in which we all (accounting scholars and professionals) think about the nuts and bolts of our craft, that is, how to design data visualizations in 'aesth-etically' effective reports. The choice is between a belief in facts and "matters of fact" or the exercise of judgements and the interrogation and scrutiny of "matters of concern" (Latour, 2005). Pursuing the former will lay the basis for a logical argument in favour of having algorithms replace double-entry, coding experts replace accountants, and data scientists replace accounting professors. Pushing, and even lobbying, for the latter will instead make accounting practice, its profession, and academic counterpart, flourish for the years to come. Or at least so I hope and believe.

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